

2009 Operation IceBridge
Low-Altitude Antarctic Land Ice Flights

Draft Flight Plans
as of 14 September 2009

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Preface

Here we present an initial draft of science flight plans for the fall IceBridge effort, utilizing NASA's DC-8 aircraft operating from Punta Arenas, Chile. The primary science instrument for these flights is NASA's Airborne Topographic Mapper (ATM), a scanning lidar which operates from altitudes between 1000 and 3000 feet above ground level. The University of Kansas MCORDS radar depth sounder is also an important instrument for these flights, and several other instruments are expected to collect data as well.

These flight plans were prepared in consultation with Bob Thomas, and incorporate input from Eric Rignot, Ian Joughin, Ted Scambos, Martin Truffer and others. The general thrust of this suite of flight plans is built around two pillars. First, we aim to overfly ICESat ground tracks over scientifically interesting areas, in keeping with the motivation of the IceBridge concept. Second, we leverage the accomplishments of the three previous ATM/radar campaigns in west Antarctica by repeating most of the flight lines occupied during those campaigns, which were already targeted to the areas identified during IceBridge planning. In addition to these, we also intend to fly other important science targets as these are brought to our attention and as resources allow.

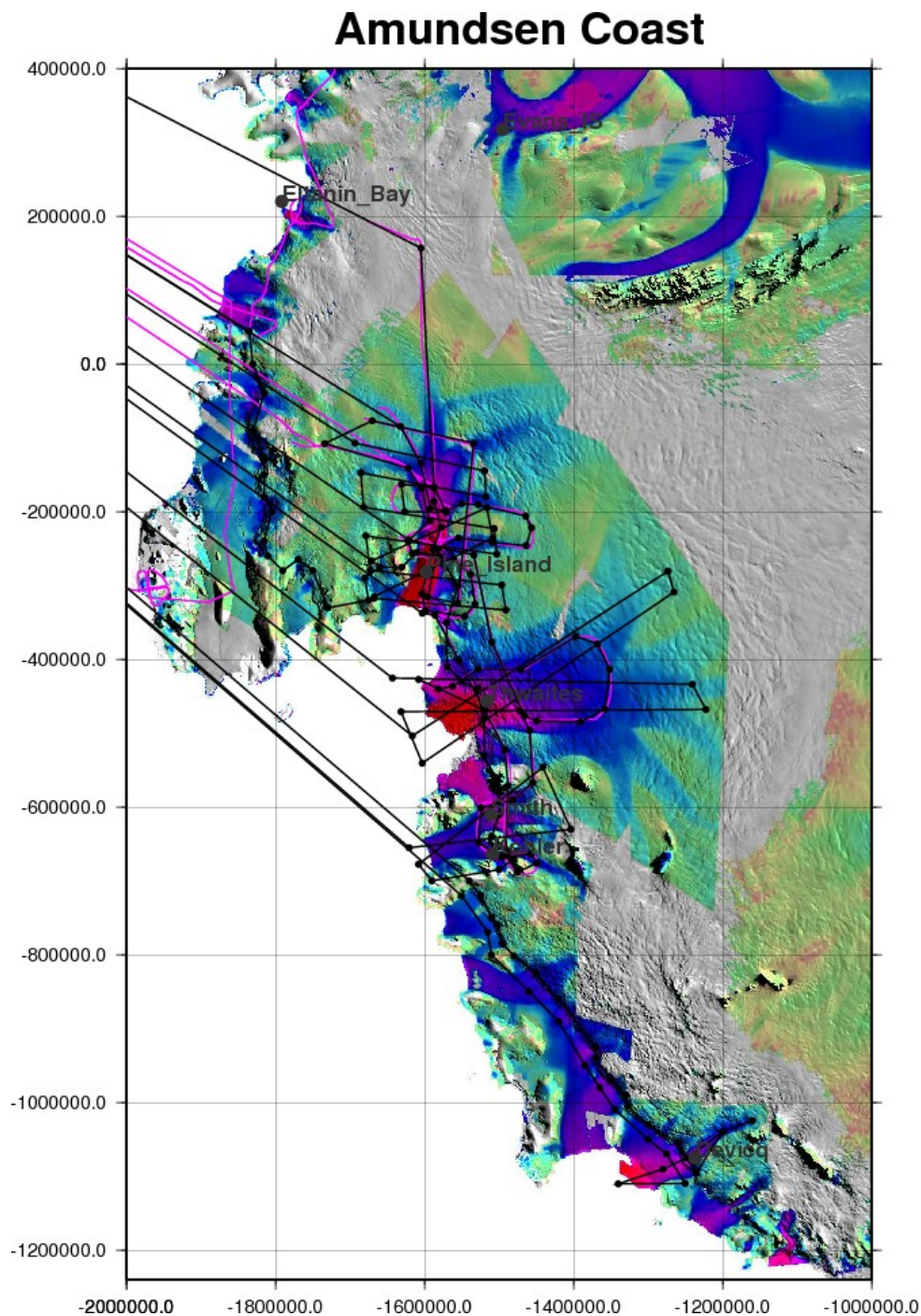
Since the first draft of this document was prepared, we at the ATM project have installed our lidar instrument and precision navigation gear aboard the NASA DC-8, and tested these extensively during a 9-hour test flight from southern California. We regard this flight as quite successful. It demonstrated several key capabilities which were to some degree question marks, to us, beforehand. First of all, we built a vastly updated version of our precise navigation system and tested it during the flight, and we believe it worked even better than the original version did. We also flew a low-altitude terrain-following segment over the Mojave desert which was in many ways representative of our upcoming operations over west Antarctica in the fall. As a result we are much more comfortable with the ability of the large DC-8 platform to perform adequately to accomplish the mission. Nevertheless some questions remain, chief among them the endurance of the aircraft with large segments of the mission flown at low altitude. We feel we have a reasonable model of this, however, and the flight plans presented here conform to the performance limitations depicted by that model, for the most part.

The flight plans presented here are depicted on InSAR ice velocity data provided by Eric Rignot. Warm colors (reds) denote fast ice, and cool colors (blues) represent slower ice. They are organized into two distinct geographical categories – the Amundsen coast region and the Peninsula, although the Peninsula 1 mission in particular bridges the gap between the two. In all cases ATM/radar flight lines from 2002, 2004 and 2008 are depicted as pink lines, and the planned missions for 2009 are shown in black. Estimated total and survey flight times are shown for each flight. The presentation of the flight plans in the form shown here are intended for discussion about science objectives. They do not directly include specific latitude and longitude information and thus are not intended to be of any direct use to aircraft operations personnel, though of course they can be presented in that fashion at the appropriate time.

Amundsen Coast Overview

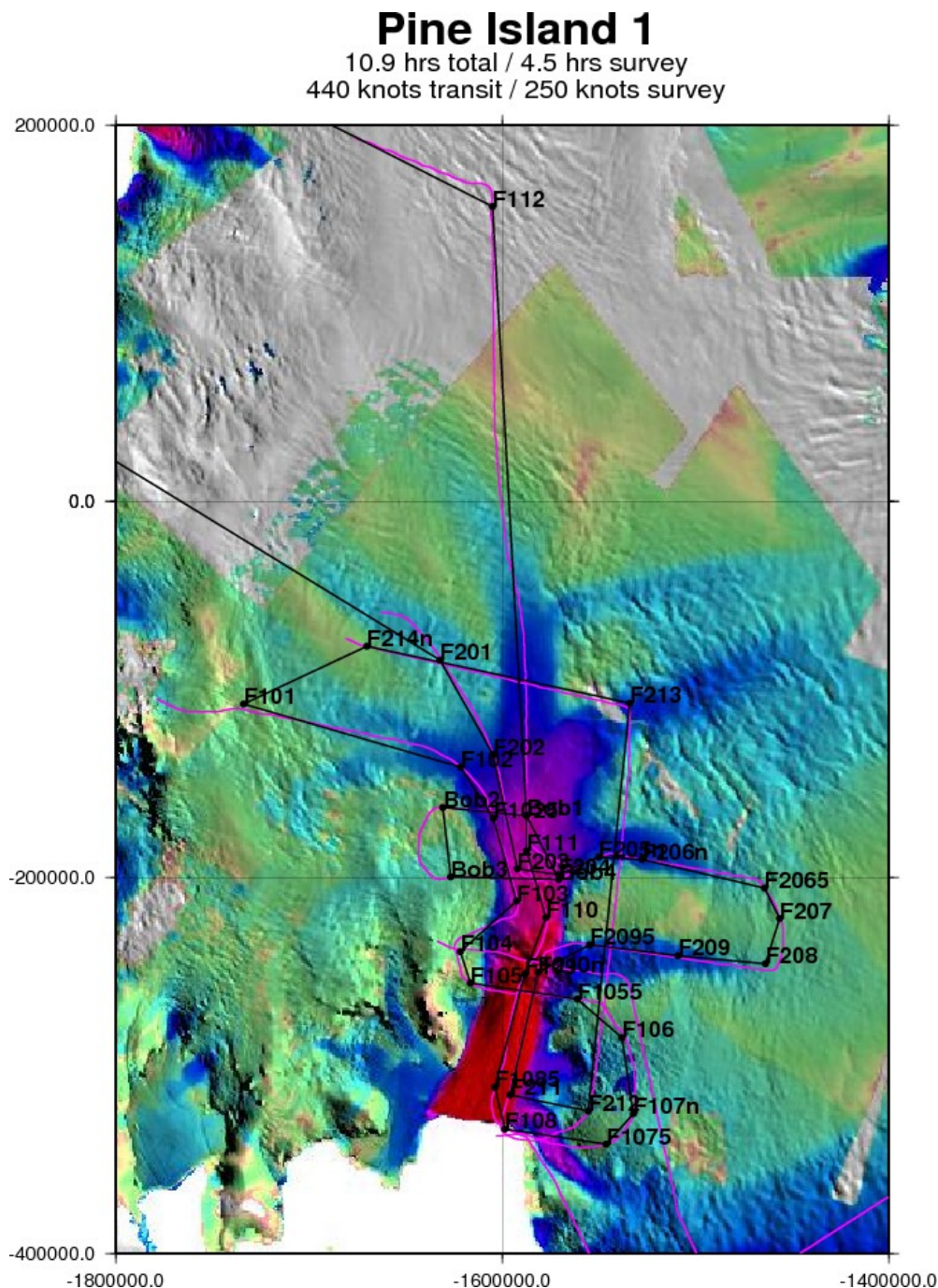
The figure below shows the six draft flight plans for the Amundsen Coast. The individual flights are shown in detail in the following pages. Two of the flights are dedicated to re-flying the 2002 and 2004 flights over Pine Island, Thwaites, Smith and Kohler glaciers. The other four are dedicated to flying ICESat lines, a dedicated line just inshore of the Eric Rignot-provided grounding line for determining ice flux, and a roughly parallel line offshore, over the Getz Ice Shelf, for determining basal melting rates of the near-shore ice shelf.

All science target requests for the Amundsen coast area which I am aware of are incorporated into these plans.



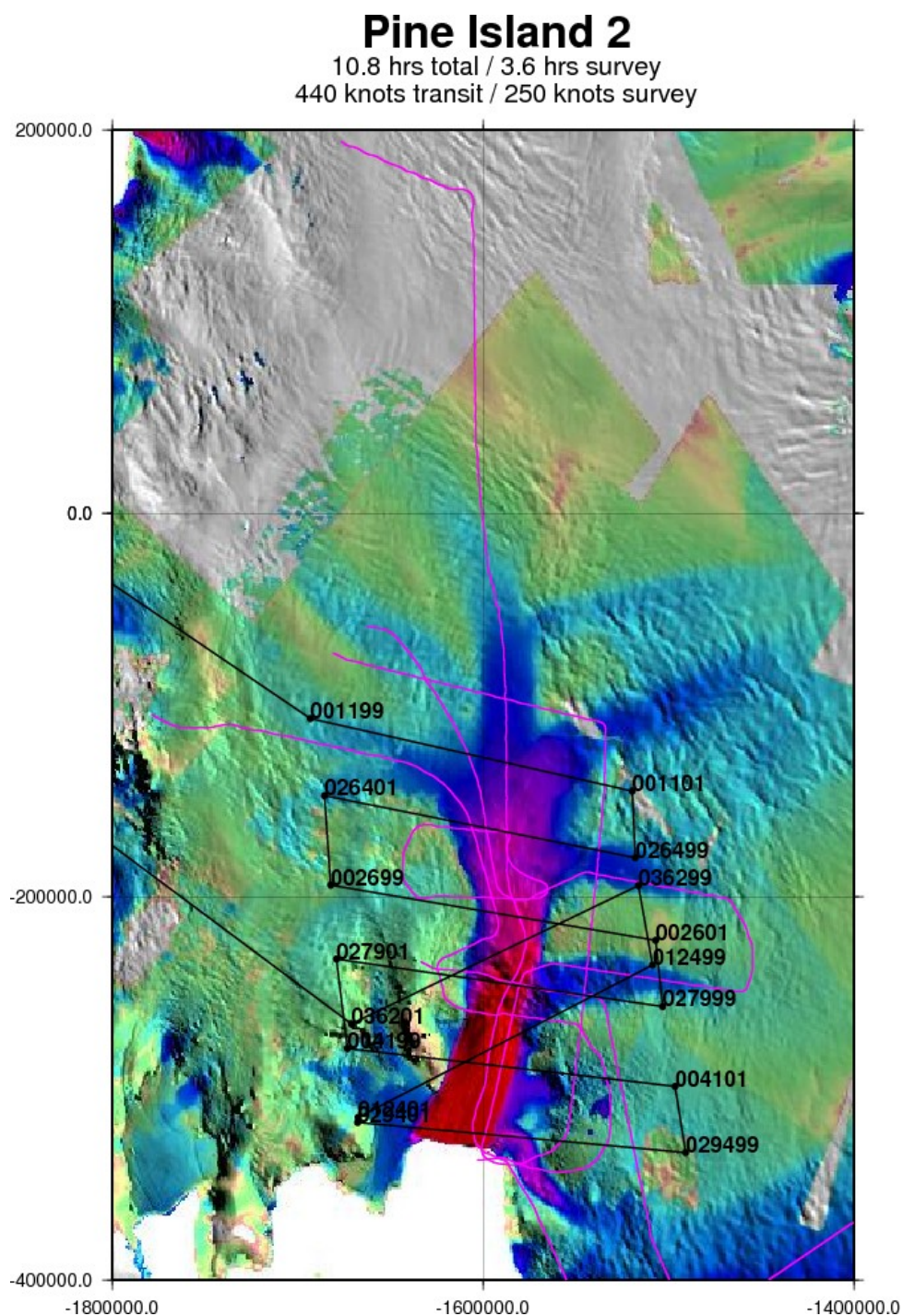
Mission Pine Island 1

This flight is a dedicated resurvey of the PIG (Pine Island Glacier) flight lines first flown by the NASA/CECS/Armada de Chile project in 2002, a subset of which was reflown in 2004. A few of these lines are overflights of the old 183-day reference ground track which was planned for ICESat before the premature failure of laser #1. Our initial estimates of DC-8 endurance indicate that the lines flown during two of the 2002 flights can perhaps be flown in one DC-8 flight, though this mission may be 20-30 minutes too long as currently planned.



Mission Pine Island 2

This flight is dedicated to overflying ICESat 33-day ground tracks over the main trunk of Pine Island Glacier. It includes 6 descending tracks and 2 ascending tracks. The ground tracks are from the 33-day subset of the 91-day orbit, during which lasers 2 and 3 were typically operated. This mission may be 15-20 minutes too long as currently planned.

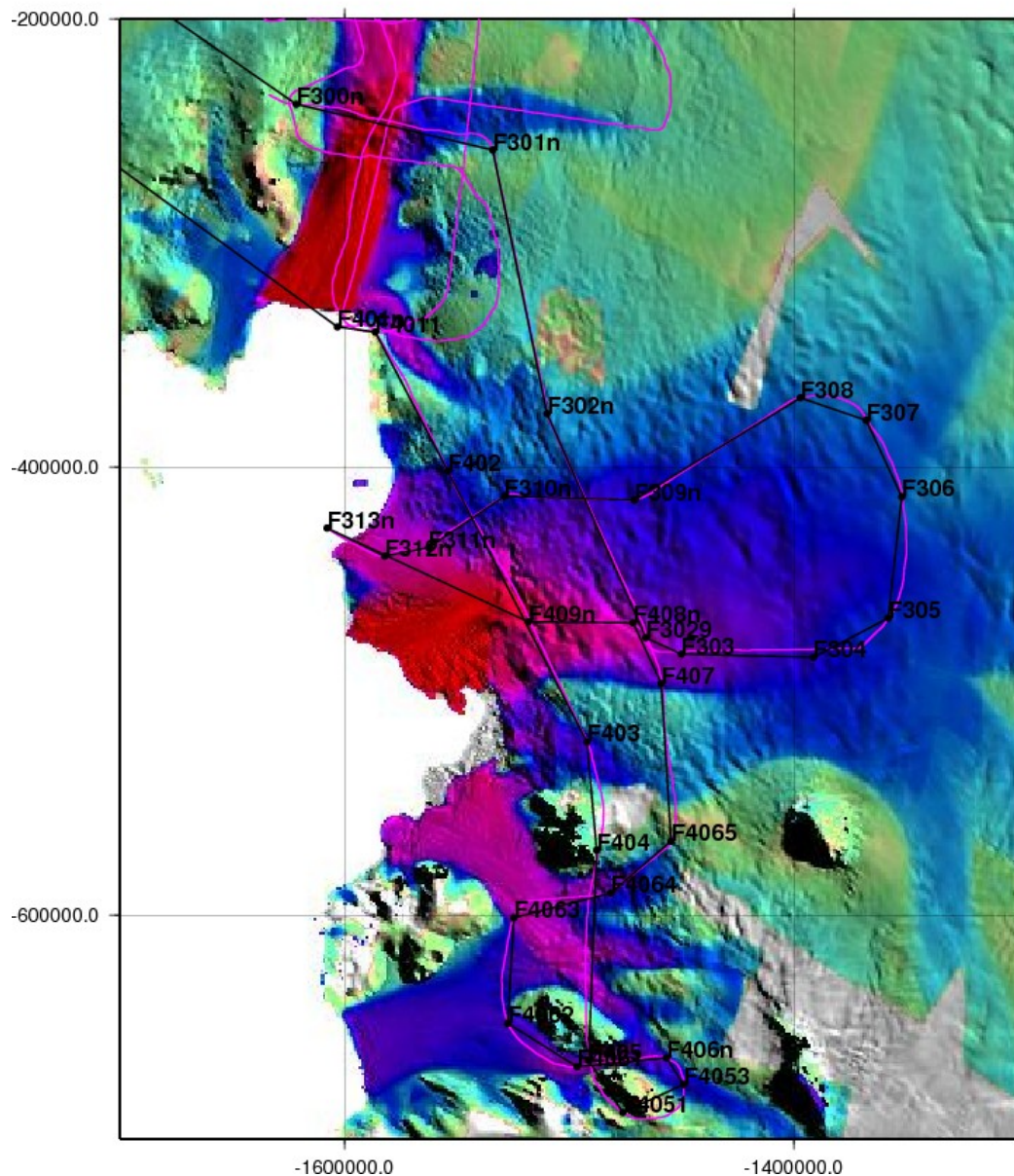


Mission Thwaites-Smith-Kohler 1

This flight is dedicated to overflying the lines over these three glaciers (plus one remaining line over Pine Island Glacier) originally flown by the NASA/CECS/Armada de Chile project in 2002. This mission and mission “Pine Island 1” together reoccupy all of the Amundsen coast lines from the previous NASA altimetry missions in this area, with the exception of a line along the Abbott Ice Shelf flown in 2004 in conjunction with a separate University of Kansas mission over Thurston Island.

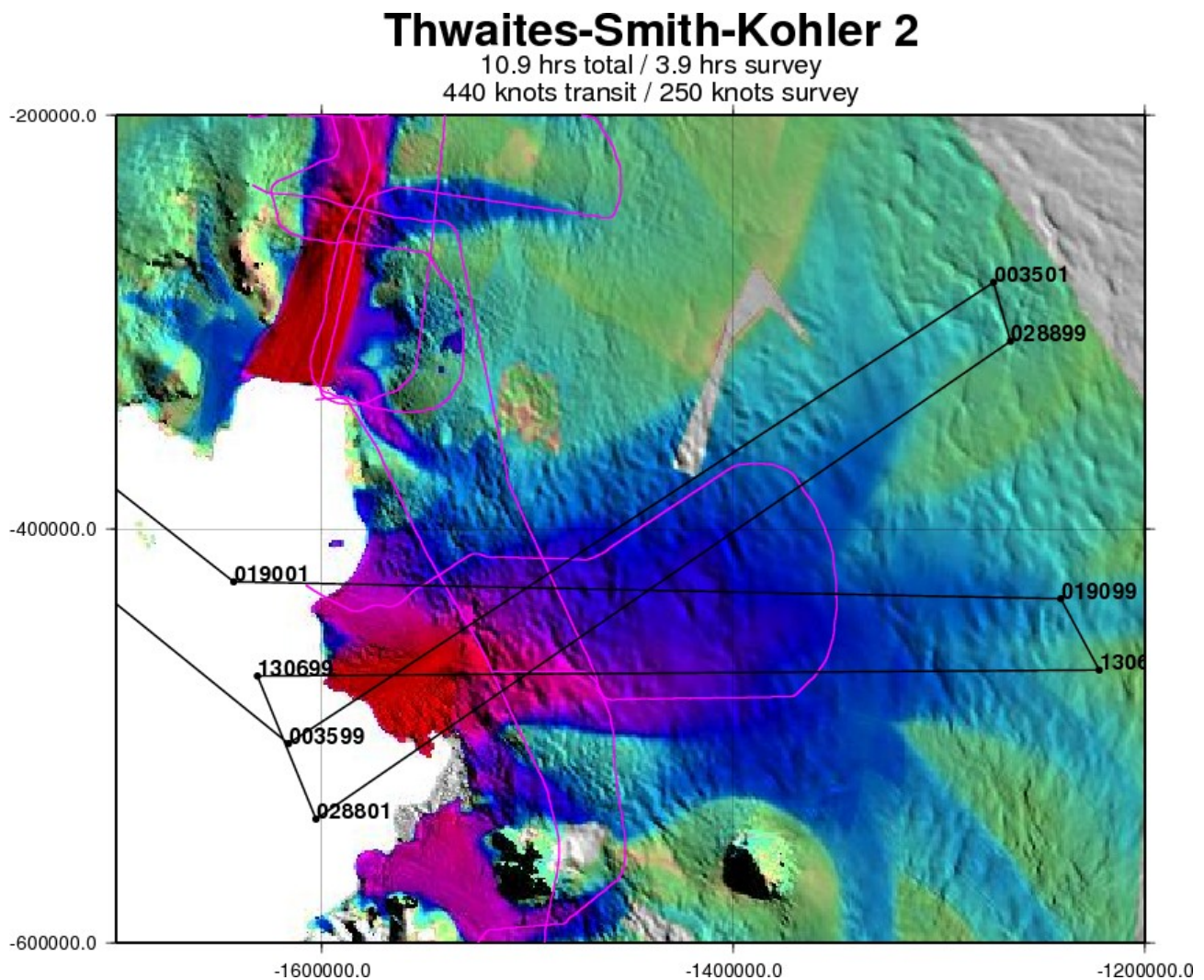
Thwaites-Smith-Kohler 1

10.5 hrs total / 3.7 hrs survey
440 knots transit / 250 knots survey



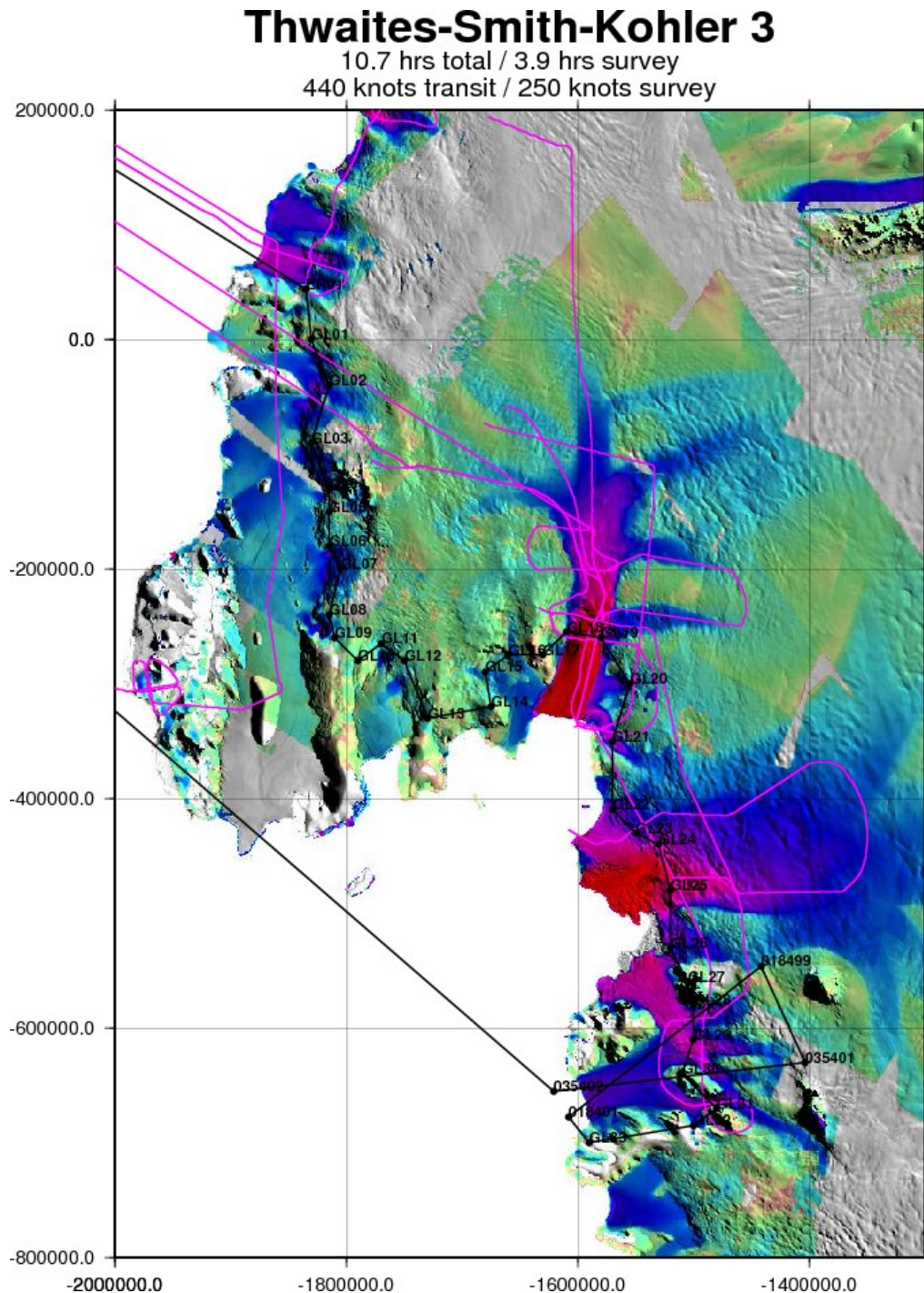
Mission Thwaites-Smith-Kohler 2

This flight is dedicated to overflying ICESat 33-day ground tracks over Thwaites Glacier. It spends the entire time over four ICESat tracks in an attempt to broadly sample the catchment, rather than survey the lower portion in more detail. This current plan largely ignores the western third of the catchment, but is probably slightly too long even so.



Mission Thwaites-Smith-Kohler 3

This flight is dedicated to two objectives: first, overflying the eastern portion of a coast-parallel ice flux line, and second, overflying a pair of ICESat 33-day ground tracks over Smith and Kohler Glaciers. Mission “Getz 1” completes the coastal flux line, from Kohler Glacier west along the Getz Ice Shelf. A weakness of this design is that it requires a large area of clear weather – about 1000 km of coastline. But since the coastal line is primarily a radar, not lidar, target, can we fly this (possibly at higher than usual altitude) above low clouds, dispense with the lidar data, and capture the radar data only? Is this acceptable to the community, assuming we could get lidar data over the ICESat lines at Smith and Kohler?

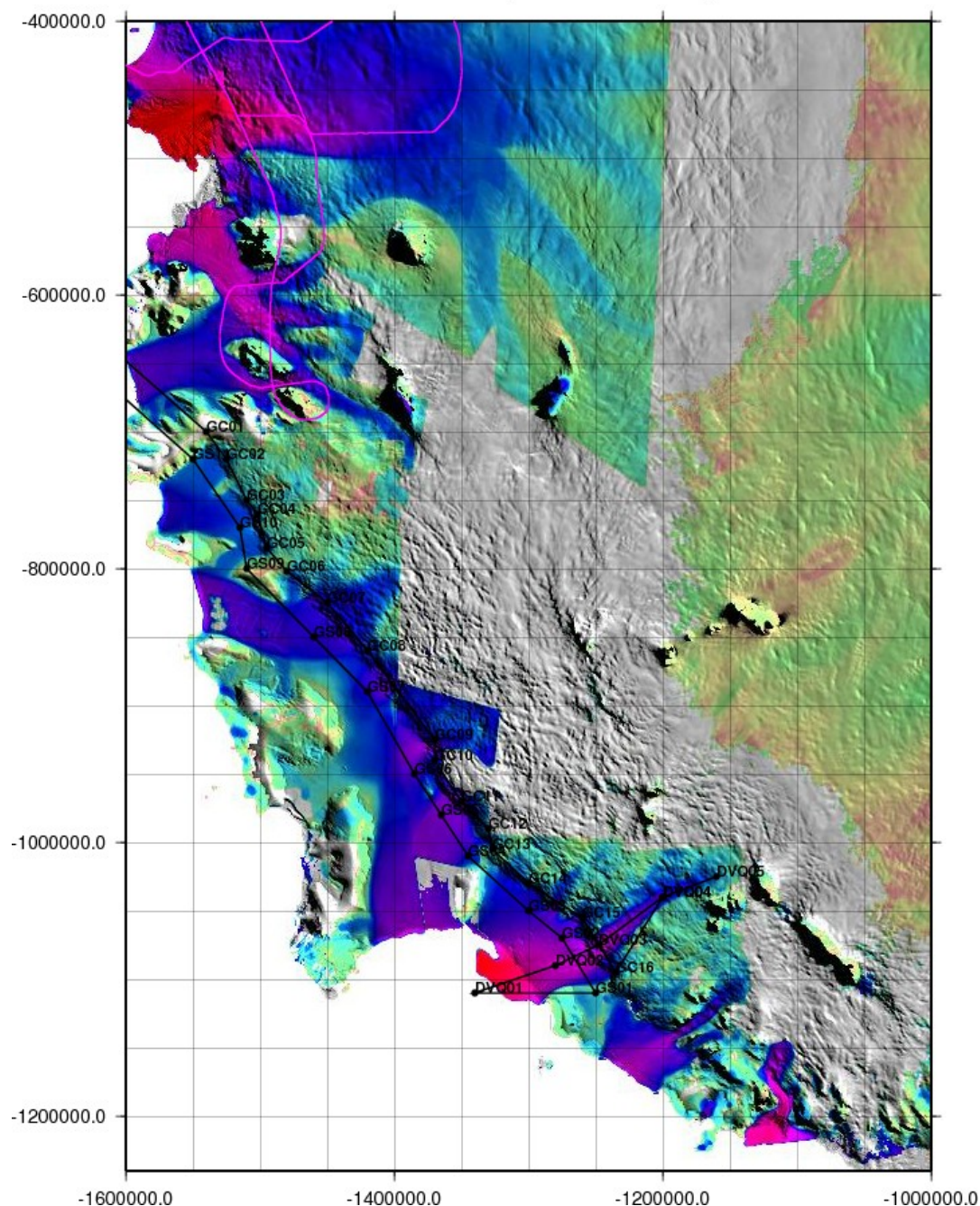


Mission Getz 1

This flight is dedicated to (a) completing the coastal flux line started in mission “Thwaites-Smith-Kohler 3”, (b) surveying the centerline of Devicq Glacier, and (c) flying a line over Getz Ice Shelf parallel to the grounding line for measurement of basal melting of the shelf. It does not include any ICESat tracks. The mission is probably near the maximum length as planned, and like the previous mission, requires a large area of clear weather.

Getz 1

10.8 hrs total / 3.1 hrs survey
440 knots transit / 250 knots survey



Antarctic Peninsula Overview

The figure below summarizes the 4 planned flights for the Antarctic Peninsula. In the first draft of these plans we had 6 planned missions. We condensed the more important parts of three of those original plans into a single mission. One of those original plans we considered to be unflyable by the DC-8 because of its complexity, steep terrain and sharp turns. This mission has been greatly simplified and incorporated into the Peninsula 3 mission below. The old Peninsula 6 mission, which was composed entirely of ICESat tracks over Larsen-C, was almost entirely eliminated, with two of its ICESat lines incorporated into the new Peninsula 3.

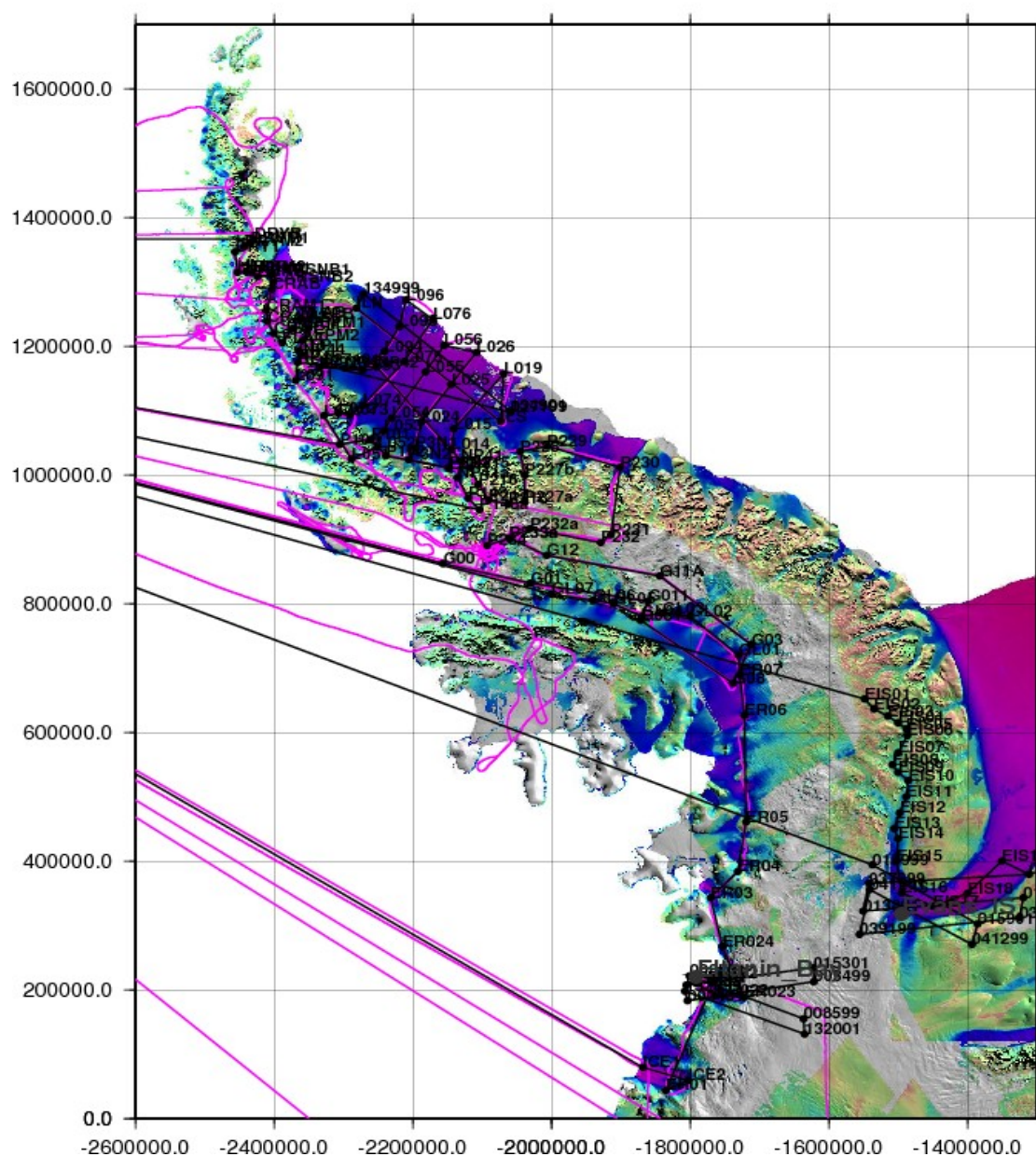
The plans presented in the following pages do not include an attempt to refly the 081030 flight, which concentrated on Alexander Island and the Wilkins Ice Shelf, and also included a great deal of maneuvering over Fleming Glacier. This mission was requested and designed by our CECS collaborators in 2008.

In addition to these, we acknowledge the following requests which are not currently incorporated into the flight plans below:

- (1) an “array” of sounding radar data over the LARISSA “Site Beta” drill site (Ellen Mosely-Thompson)
- (2) the ridge crest from north of Drygalski to Dyer Plateau (Ted Scambos notes from the July GSFC science meeting)
- (3) Wilkins Ice Shelf (Ted Scambos notes)
- (4) parts of the original “unflyable” Peninsula 3 mission, including a sinuous and difficult-to-fly path along the inshore edge of the Larsen-C which transitioned multiple times from ice shelf to steep terrain and back
- (5) Adie and Cabinet Inlets (Ted Scambos notes)
- (6) Channel crossings of Crane, Flask, Leppard and possibly other glaciers (Martin Truffer)

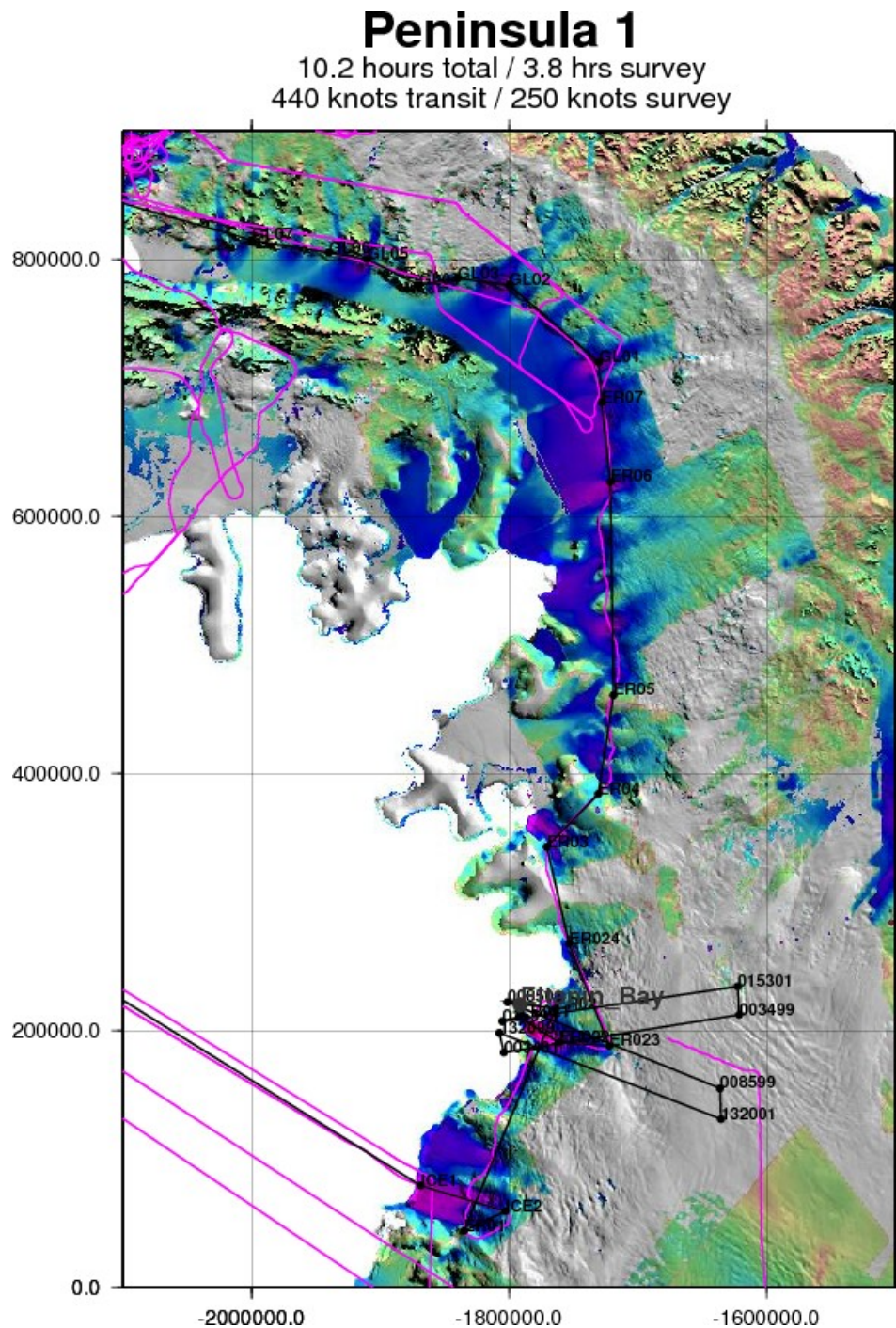
The Peninsula 2 mission below is currently only 8.2 hours long and approximately 2 more hours can be added to it, possibly incorporating some of the outstanding targets above, but certainly not all. Another possibility would be to eliminate one or consolidate more of the Amundsen Coast flights and free those flight hours for use on the Peninsula.

Antarctic Peninsula



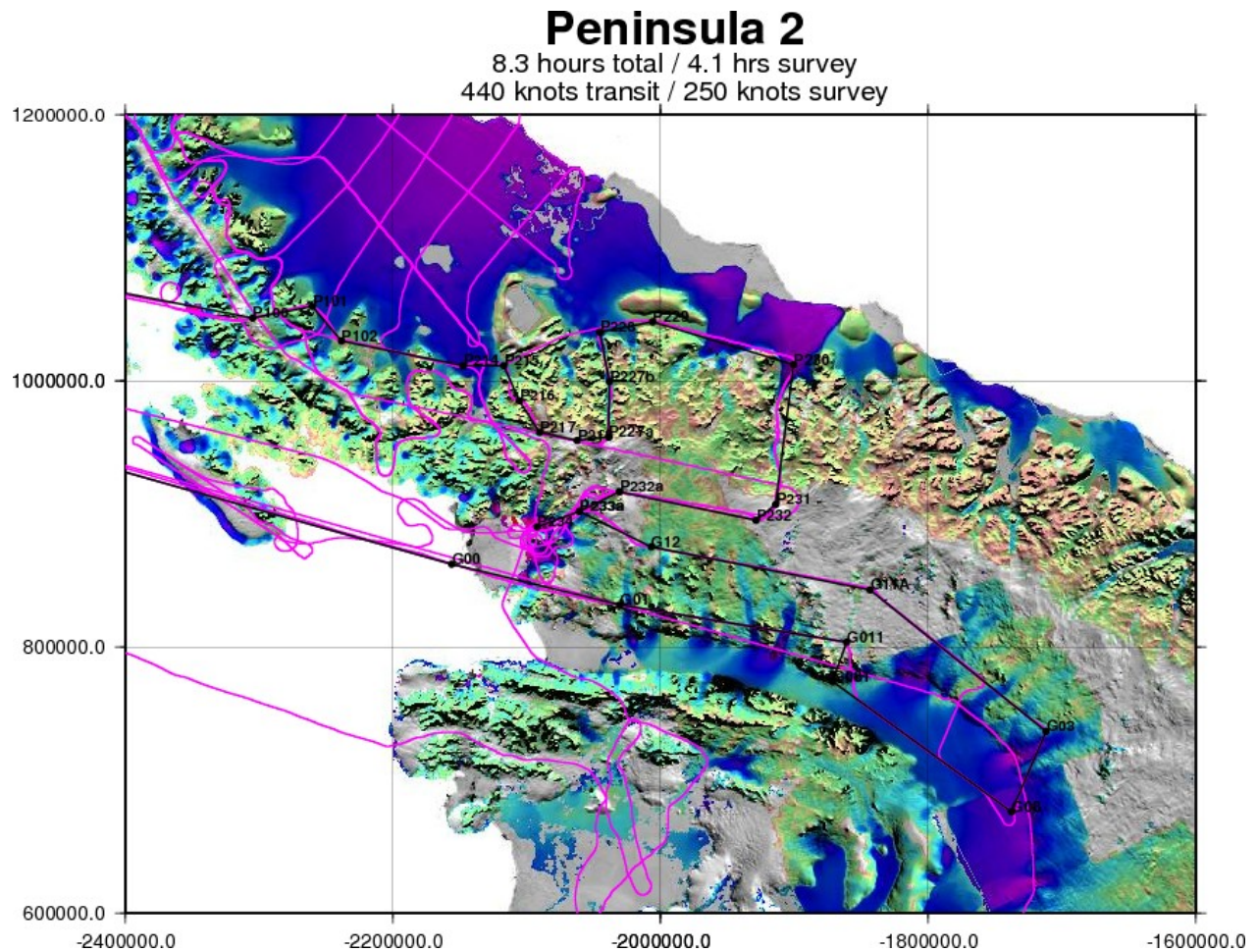
Mission Peninsula 1

This flight is dedicated to (a) repeating the 081012 NASA/CECS/Armada de Chile mission, which continues the Amundsen coastal flux line north adjacent to the George VI Ice Shelf, and (b) occupying two ascending and two descending ICESat lines over the major glacier flowing into Eltanin Bay, plus occupies the centerline of that glacier (whose name I do not know).



Mission Peninsula 2

This flight is dedicated to repeating the 081014 NASA/CECS/Armada de Chile mission, which occupies Fleming Glacier, Mobile Oil Inlet, and several other glaciers, plus occupies a pair of ICESat tracks, one on the George VI Ice Shelf and a parallel one over Palmer Land. At 8.3 hours, this mission can be lengthened by 2 hours or slightly more.

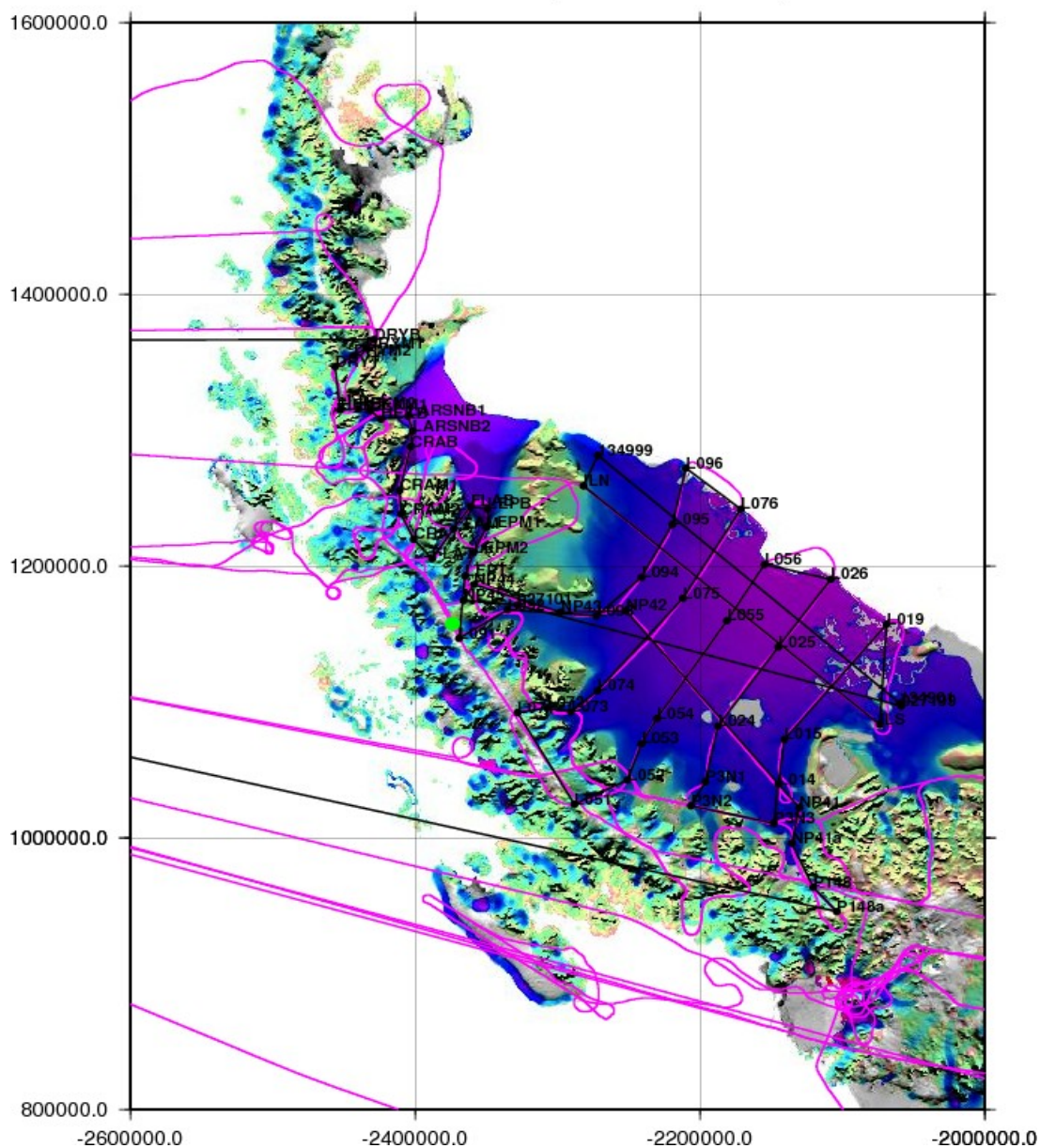


Mission Peninsula 3

This flight is an amalgamation of the 081021 and 081026 NASA/CECS/Armada de Chile missions, which occupied a number of glaciers draining the eastern side of the Antarctic Peninsula and several lines on the Larsen-C Ice Shelf originally defined by Eric Rignot. The 081021 mission was greatly simplified and condensed, though some of the more notable parts we preserved here are the Drygalski, Hektor, Crane, Flask and Leppard Glacier longitudinal surveys. We also added several ICESat lines on the Larsen-C.

Peninsula 3

10.5 hours total / 6.5 hrs survey
440 knots transit / 250 knots survey



Mission Peninsula 4

This flight is dedicated to flying five ICESat tracks over the Evans Ice Stream. It also occupies the centerline of the main ice stream, and that of its longest tributary which extends 250 km north of the main trunk. None of these lines have been flown previously.

